Gamified Teaching- Learning at the Secondary Stage of Schooling: An Alternative Technique

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Abstract

The Indian school education system has been grappled with several challenges within the classroom setting such as large class sizes, rote learning, lack of student engagement, and limited critical thinking opportunities. To address these issues technological interventions are constantly being made. National Education Policy, 2020 has also put forth recommendations to reform the higher education system. The NEP emphasizes the significance of integrating technology and gamification to foster student engagement and critical thinking skills. Gamification is a potent technique that can be used in Indian classrooms to foster positive learning experiences in students. By introducing gamification elements and tools, science subjects can be taught more effectively so as to develop scientific thinking, scientific literacy, and problem-solving through scientific methods. This paper highlights a few popular gamification applications that a teacher can use as per the requirement of the subject matter and students to make their learning dynamic. The paper attempts to explore the role of gamification in transforming secondary science classrooms.

***Keywords**: Gamification, National Education Policy 2020, Gaming Elements, Gaming Tools, Game-based platforms, Secondary Science Classroom.*

Introduction

Researches have shown that active engagement and motivation play a crucial role in boosting academic achievement among students (Williams, 2010). Active learning approaches, such as constructivist course design, inquiry-based teaching, collaborative activities, and technology-enabled activities, have been found to improve student motivation, enjoyment, and long-term retention of knowledge (Ruiz-Primo et al., 2011; Glynn & Koballa, 2006; Hancock, 2002). The National Education Policy 2020 states that wherever and wherever traditional, in-person forms of education are not practicable, technology will be used to its fullest potential to ensure preparedness with other, high-quality learning options. Gamification as a constructivist instructional approach is a relatively recent development. It harnesses students' interest in games and technology and redirects it to their learning. The engaging nature of gamification makes learning interesting and fun for adolescent students

thus improving their class performance (Fan & Wolters, 2014). It also helps concertize complex abstract concepts at the secondary level. Thus, in the context of secondary education in India, gamification is gaining considerable attention. In simple words, Gamification can be best described as incorporating game design elements in non-game contexts, specifically in learning scientific concepts and standards (Deterding et al., 2011). This instructional approach, whether implemented with or without technology was first documented in 2008 (Ceker & Ozdamli, 2017). The worldwide interest in gamification in education has extended to the realm of science education, and this enthusiasm is particularly relevant in the Indian context (Lindberg et al., 2019; Ozcinar et al., 2019). Recent research has indicated that gamification strategies benefit students of various demographics, including those of different ages, races, genders, and income levels (Chapman & Rich, 2018). There is evidence that gamification can be used to enhance student motivation and interest in their learning (Bal, 2019; Chapman & Rich, 2018; Rouse, 2013). Additionally, gamification has been found to facilitate effective classroom management (Bal, 2019; Kirillov et al., 2016), foster creativity and collaboration (Bal, 2019), and promote academic achievement (Rouse, 2013). By incorporating game-like elements such as points, badges, leaderboards, and challenges, gamification in education seeks to create an interactive and immersive learning experience that fosters active participation and intrinsic motivation among students.

Bishop and Harrison (2021) asserted that secondary-level instruction should be active, purposeful, and democratic. Many students encounter difficulties such as disengagement, apathy, and low motivation within traditional classroom settings By harnessing the inherent appeal of games, educators can make complex concepts more accessible, promote problem-solving skills, and stimulate critical thinking.

Gamification Elements and Tools

Gamification is a method of incorporating game elements into non-game situations (Deterding et al., 2011). According to research, gamification can increase engagement by using motivating features like leveling up, leaderboards, and point systems in various fields, including exercise, healthcare, business, and education (Hamari et al., 2014; Zichermann & Cunningham, 2011). In the context of education, applying gamification has the potential to improve critical thinking, multitasking, and other essential skills required for students to succeed in the digital age. Gamification fits the needs of Indian students by enhancing critical thinking, multitasking, and other crucial skills. However, it is crucial to

note that gamification is distinct from game-based activities, as it focuses on specific mechanisms that support learning rather than replicating the entire gaming experience (Ceker & Ozdamli, 2017). Games are used as tools to achieve specific educational objectives, creating a unique learning environment outside the realm of traditional games. For gamification to be effective in Indian classrooms, it is crucial for educators and students alike to understand how to effectively utilize game techniques and principles.

Gamification tools and platforms available for educators

Educators have access to a variety of gamification tools and platforms designed specifically for the educational context. These tools provide user-friendly interfaces, pre-built game mechanics, and customization options to facilitate the implementation of gamified learning experiences.

- **Leaderboards and progress bars** - Leaderboards serve as dynamic scoreboards that rank participants based on their point accumulation, stimulating healthy competition and inspiring continuous effort. On the other hand, progress bars are most commonly used in games to signify a player & progression within a specific activity. Unlike leaderboards, progress bars are typically not displayed publicly within game systems, as their purpose is to indicate individual advancement rather than impacting the standing of other players in the game. This distinction is highlighted by Costa, Wehbe, Robb, and Nacke (2013) in their research on gamification, emphasizing that progress bars contribute to a player & sense of accomplishment and provide a visual representation of their journey toward achieving goals. By integrating leaderboards and progress bars into gamified contexts, educators and designers harness these powerful tools to fuel motivation, encourage healthy competition, and visually represent individual progress.
- **Badges and trophies** - Badges and trophies within gamified environments, serve as external motivators and symbolic representations of task completion. These visual rewards are closely tied to specific criteria established by the issuer of the badges (Abramovich et al., 2013; Jovanovic & Devedzic, 2014). Furthermore, some researchers perceive digital badges as a potential alternative to standardized testing, offering a formative assessment approach with enhanced student feedback (Abramovich et al., 2013). By incorporating badges into educational contexts, learners are acknowledged for their accomplishments, and their progress is continually

acknowledged and evaluated. In essence, badges and trophies in gamification serve as both motivators and symbols of accomplishment.

- **Avatars and virtual personas** - Massively multiplayer online games, or MMOGs, are one type of online gaming that has given players from all over the world a platform to communicate and connect with one another. It has been found that avatars in games can help bring artistry, creativity, and innovation to gameplay (McGonigal, 2011).
- **Levelling up** - The concept of gamification involves the utilization of a progression system within games, often accompanied by a point system or leaderboard, to showcase a player & advancement throughout the game. Levelling up in gameplay serves multiple purposes. Firstly, it serves as a tangible representation of mastery achieved by players (McGonigal, 2011). Moreover, it facilitates player recognition for the experience gained during gameplay, motivating them to continue their engagement with the game.
- **Points** - In most games, the point system has traditionally served as a primary means of incentivizing players. Thom, Millen, and DiMicco (2012) argued that a point-based system alone, devoid of other extrinsic motivators such as badges and levels, tends to generate less productivity.

Some popular gamification tools and platforms include:

- Classcraft: Classcraft is an online platform that transforms the classroom into a role-playing game, allowing educators to create quests, award points, and manage student behavior through gamified mechanics.
- Kahoot!: Kahoot! is a game-based learning platform that enables educators to create interactive quizzes and challenges. It features a competitive element with a leaderboard that displays scores in real-time, fostering engagement and active participation.
- Breakout EDU: Breakout EDU offers a physical and digital medium that enables educators to design and facilitate escape-room-style challenges. By solving puzzles and completing tasks, students work collaboratively and develop critical thinking skills.

- Edmodo: Edmodo is a learning management system that integrates gamification features, such as badges and points, into the online classroom. It provides a collaborative space for discussions, assignments, and interactive quizzes.

Gamification in Science Education

In the 21 st century, science has been proven a key factor in the advancement of health, economics, and well-being of every individual. The development of scientific thinking abilities and scientific literacy, however, does not happen in a natural way; it requires intentional scaffolding using the right educational and cultural resources (Morris et al., 2013). Further, research in the domain highlights the development of scientific thinking as the foundation of science education. Scientific thinking refers to a cognitive and systematic approach used to understand, analyse, and solve problems based on empirical evidence, logical reasoning, and critical evaluation. It involves employing the scientific method, which includes observation, hypothesis formation, experimentation, data analysis, and drawing conclusions. A number of components contribute to scientific thinking, that includes motivation, cognitive skills, and metacognition, as well as external influences like education.

The National Council of Educational Research and Training (NCERT) also recognizes the importance of developing scientific thinking among students in science learning through experimenting and gaining experiences, such as hands-on experimentation. Science education at the secondary stage should help students become engaged in learning science as a composite discipline, in using their hands and tools to design more advanced technological modules than at the upper primary stage, and in activities and analysis on issues surrounding environment and health, according to NCERT, which emphasizes the importance of science education at the secondary stage and aims to engage students in a holistic understanding of science as a composite discipline. At this point, working on locally significant science and technology projects and using systematic experimentation as a tool to discover or verify theoretical principles should be important components of the curriculum (NCERT, 2006, pg. IV). The guidelines encourage students to work practically with their hands and tools, designing advanced technological modules beyond the primary level. To achieve these goals, systematic experimentation becomes a crucial tool for discovering and verifying theoretical principles, while locally significant projects involving science and technology are deemed essential components of the curriculum at this stage (NCERT, 2006).

Replicating these guidelines in a classroom setting presents many challenges. Science education grapples with a significant issue of generating negative emotions and experiences among students. Many students find science courses challenging to comprehend, leading to higher rates of rejection and dropout (Vidakis et al., 2019). Moreover, teachers lack of interest and expertise in the subject matter, along with inadequate pedagogical skills for teaching science, can also affect students negatively (Borrachero et al., 2011). To address these challenges, it becomes crucial to improve the way students explore and comprehend scientific phenomena and concepts while encouraging active and scientific thinking (Vidakis et al., 2019). Specifically, in India, despite the laid-down guidelines, the current state of science classrooms in India faces certain challenges in providing practical training opportunities for students. Many schools encounter difficulties in offering adequate hands-on practice and experimentation due to various reasons (Kundu & Bej, 2021; UNESCO, 2022). For instance, some schools lack proper laboratory infrastructure, limiting students' exposure to practical learning experiences. Additionally, the shortage of qualified science teachers poses a hindrance to effectively engaging students in practical training (UNESCO, 2022). These issues contribute to a gap between the intended goals of science education and the actual implementation in classrooms.

Gamification, being a familiar concept to students, captures their interest and holds promise as an effective educational tool (Kalogiannakis et al., 2020). Furthermore, the implementation of gamification in science education has the potential to foster scientific thinking (Morris et al., 2013). It aligns with scientific theories, methodologies, and learning strategies, creating compatibility between education and gamification approaches (Vidakis et al., 2019). By incorporating game elements, such as challenges, rewards, and interactive experiences, gamification can stimulate students scientific thinking skills and provide a conducive environment for them to explore and apply scientific concepts (Kalogiannakis et al., 2020).

Incorporating gamification to enhance scientific thinking skills in science class

In a recent study, Kalogiannakis et al. (2020) provide a comprehensive review of the integration of gamification in science education and its benefits. The application of gamification in science education has seen a significant increase, aiming to enhance student engagement, joyfulness, and motivation while supporting science-related activities (Loganathan et al., 2019). By incorporating gaming mechanics and elements into science

lessons, gamification has the potential to overcome the obstacles faced in science education, leading to increased motivation, cognitive and metacognitive achievements, and greater student enjoyment (Morris et al., 2013). Unlike a traditional school laboratory, gamification applications create a safe and realistic environment for students to experiment without any risks or fear of accidents (Kim et al., 2018). Additionally, students are encouraged to be proactive, explore new approaches, and repeat tasks without the pressure of failure, as they remain anonymous during the process (Kim et al., 2018). Another advantage of gamification is its association with socially interactive and constructive learning environments (Kalogiannakis et al., 2020). Students who participate in a gamified environment tend to become more receptive and eager to engage in similar teaching approaches in the future (Loganathan et al., 2019). For instance, let us consider an example of a science-based mobile app that gamifies the process of learning about the solar system. Through interactive quizzes, challenges, and rewards, students can explore the planets, study celestial phenomena, and conduct virtual experiments. Such gamified applications not only enhance student interest but also provide a safe space for students to experiment and learn about astronomy without any risks involved.

Use of game-based scenarios and simulations in science lessons

Several innovative games have been developed, each designed to target specific aspects of science learning and promote scientific thinking among students (Morris et al., 2013). One such example is the game “Supercharged!” (Squire et al., 2004). In this game, students embark on a space adventure piloting a spaceship that adopts properties of charged particles. Throughout the game, they navigate through a high school electrostatics curriculum. Research has shown that students who played Supercharged! gained a deeper understanding of physics, particularly in their comprehension of physics textbook representations. Additionally, lower-achieving students experienced the most significant improvements in their understanding of the subject.

Another remarkable gamified learning experience is “Quest Atlantis” (Barab et al., 2005), aimed at elementary and middle school students. The game introduces elements of the science curriculum related to social aspects of science, such as environmental awareness and social responsibility. While playing “Quest Atlantis” students immerse themselves in a world that fosters pro-science values, nurturing not only the skills required by scientists but also those essential for scientifically literate citizens. For a more authentic and immersive learning

experience, “Environmental Detectives”. The game encompasses various scientific thinking elements, including data collection, evaluation, asking questions, collaboration, and argumentation. Players must employ scientific and engineering skills to address the complex, open-ended problem presented in the game.

The educational games mentioned earlier are more than just typical games; they immerse players in simulations where variables interact, providing an explicit understanding of the system dynamics. These games present challenges and goals, requiring players to employ various operations, strategies, and resources to achieve success. Students must actively learn how the system functions, understand the rules, identify the most successful techniques, and acquire insight into the strategies that work as they interact with these simulations (Gee, 2009). Students are inspired to think critically and analytically by this hands-on, problem-solving method within the gaming environment, which builds a deeper knowledge of scientific subjects. For example, in “Supercharged!” students not only grasp the theoretical concepts of electrostatics but also actively navigate through space as charged particles, experiencing firsthand the interactions between electrical charges. Similarly, “Quest Atlantis” presents a virtual world where students explore environmental and social issues, encouraging them to understand the complexities and implications of their actions in a realistic context. Through these interactive simulations, students develop a sense of agency and ownership in their learning journey (Morris et al., 2013). They are empowered to explore, experiment, and draw connections between cause and effect, all while actively participating in the learning process. The gamified approach facilitates a sense of curiosity and excitement, motivating students to persist and conquer challenges as they unravel the intricacies of science (Loganathan et al., 2019). As educators leverage the potential of gamification in science education, they open up a world of possibilities to nurture a scientifically literate generation. By blending the joy of gaming with the pursuit of knowledge, educational games become powerful tools for igniting students’ passion for science and equipping them with valuable scientific thinking skills that extend far beyond the confines of the virtual environment.

Conclusion

In conclusion, gamification has emerged as a powerful tool for enhancing student engagement, motivation, and learning outcomes in secondary-level subjects. By incorporating gamification elements and strategies, educators can create dynamic and immersive learning

experiences that promote active participation, critical thinking, and problem-solving skills. Through gamified approaches, interactive simulations, and storytelling, students can develop a deeper understanding of complex concepts in Biology, Physics, and Chemistry. The alignment of gamification strategies with curriculum goals and learning objectives ensures that gamified experiences are meaningful and supportive of educational outcomes. A capacity-building program is imperative to foster gamified teaching techniques in teachers. By equipping educators with skills to integrate game-based techniques into curricula, it enhances student engagement and critical thinking. Such initiatives will empower teachers to design interactive learning experiences that align with modern educational trends, ensuring effective knowledge transfer while nurturing creativity.

While gamification offers significant benefits, challenges such as overemphasis on extrinsic motivation and design considerations need to be addressed. Exploring emerging technologies and trends, including AR, VR, AI, and mobile learning, can further enhance gamified learning experiences.

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